

Applying Transfer Learning ResNet-50 for Tracking and Classification of A Coral Reef in Development The Mobile Application with Scrum Framework

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Intisari— Terumbu Karang memiliki peran penting dalam menjaga keseimbangan ekosistem di lautan. Penelitian ini bertujuan untuk membangun aplikasi mobile untuk melacak keberadaan terumbu karang serta melakukan klasifikasi untuk mengidentifikasi terumbu karang dengan penyajian informasi berupa nama spesies, jenis klasifikasi karang (karang keras atau lunak), akurasi, dan sebaran area keberadaan terumbu karang. Untuk pencapaian tujuan tersebut, terdapat 2 (dua) fokus utama dalam penelitian ini yaitu membangun aplikasi mobile dengan framework Scrum serta mengimplementasikan Transfer Learning (TL) ResNet-50 pada aplikasi mobile untuk mendukung fitur yang terdapat pada aplikasi. Penelitian ini, memanfaatkan Flutter untuk membangun aplikasi mobile, Deep Learning of Transfer Learning (TL) ResNet-50 digunakan untuk klasifikasi, Google Cloud Platform untuk menerapkan Rest API dan menerapkan model TL ResNet-50 telah dibuat sebelumnya, serta database MongoDB untuk menyimpan data terumbu karang beserta daerah terumbu karang ditemukan. Adapun spesies terumbu karang yang dapat diklasifikasikan untuk diidentifikasi ada 5 (lima) jenis yaitu *Acropora Clathrata*, *Acropora Florida*, *Cyphastrea Microphthalma*, *Diploastrea Heliopora*, dan *Pachyseris Speciosa*. Total dataset Terumbu Karang memiliki 2197 gambar dan dilatih dengan TL ResNet-50 dan menghasilkan akurasi 0,9594 atau 96% untuk klasifikasi Terumbu Karang. Pemanfaatan Scrum framework pada penelitian ini, membantu untuk menghasilkan produk berupa aplikasi mobile dalam waktu singkat serta membantu dalam pengelolaan proses pengembangan aplikasi.

Kata kunci— Klasifikasi, TL ResNet-50, Mobile, Google Cloud Platform, Rest API, Scrum Framework, Terumbu Karang.

Abstract— A Coral Reef has an important role in keeping a balanced ecosystem in the ocean. This research aims to develop a mobile application to track the presence of Coral Reefs and classify to identify Coral Reefs with a presentation of information names of species, the type of classification of coral (hard or soft coral), accuracy, and distribution of certain areas where Coral Reefs exist. To achieve this goal, there are 2 (two) main focuses in this research, namely developing mobile applications with the Scrum framework and implementing Transfer Learning (TL) ResNet-50 in mobile applications to support the features contained in the application. This research, utilized Flutter for deploying a mobile application, Deep Learning of Transfer Learning (TL) ResNet-50 for the classification of Coral Reefs, the Google Cloud Platform to implement the Rest API and apply model TL ResNet-50 has been created previously, and the MongoDB database for storing data of the Coral Reef along with areas founded. Five types of Coral Reef species could be classified to identify i.e. *Acropora Clathrata*, *Acropora Florida*, *Cyphastrea Microphthalma*, *Diploastrea Heliopora*, and *Pachyseris Speciosa*. A total dataset of a Coral Reef has 2197 images and is trained with TL ResNet-50 and it has resulted in an accuracy of 0.9594 or 96% for the classification of Coral Reef. Utilization of the Scrum framework in this research assists to produce a product in the form of a mobile application in a short time and assists in managing the application development process.

Keywords— Classification, TL ResNet-50, Mobile, Google Cloud Computing, Rest API, Scrum Framework, Coral Reefs.

I. INTRODUCTION

Indonesia is known for the world's highest marine biodiversity, the coral triangle region, and is recorded to have 569 or 69 % species and 83 or 76% genera of stony corals around the world [1]. Indonesia's geography contains 16.056 islands and 2/3 of the total area, representing approximately 5.8 million km² is water [2] then the tropical climate makes Indonesian waters has warm temperature through the years and are the best suiting for plenty of growth of Coral Reefs.

Coral Reefs are valuable and important ecosystems on the earth such as support marine life ecosystems, including species of fish, plants, animals, or undiscovered species of organisms living and around Coral Reefs. The Coral Reef structures are also able to withstand 97 percent of the energy from waves, storms, floods, erosion, and so on [3]. When Coral Reefs are destroyed, many creatures underwater are less able to survive in their habitat and communities around them including human living.

The variety of species in Coral Reefs has become a magnetism for study and research, especially implementation technology on it. There are numerous classifications or detection to identify a variety of species in Coral Reefs using deep learning. Deep learning would store knowledge of Coral reefs that would become a dataset and then train a model to show information based on a classified Coral Reef through an image or video.

Using deep learning for classification, object detection or recognition in Coral Reefs has been done in numerous research considering the important role of Coral Reefs and the challenging tasks in it and has the prospective to assist a problem to solve intuitively. Wan et.al [4] proposed a Multi-Scale method based on a Convolutional Neural Network and Support Vector Machine (CNN-SVM) which combines spectrum, texture, and bi-dimensional empirical mode decomposition (BEMD) based scale separation algorithm to fully learn multi-scale information of Coral Reefs of Zhaoshu Island and Zhong Island in the Xisha Archipelago, China.

Sharan et.al [5] applied Convolutional Neural Network (CNN) after an input image is augmented by segmentation, rotation, and resizing and then the augmented image is processed into an enhancement step by the RGB approach. Hopkinson et.al [6] proposed an approach to classify 3D reconstruction of sections of Coral Reef using software named Structure-From-Motion to generate a 3D reconstruction from Coral Reef images extracted from video and then integration information from several points of observations using ResNet-152 to classify extracted features from images with classification class such as Algae, Antillogorgia, G.Ventalina, A. Palmata, P. Astreoides, S. Siderea, Orbicella, Sea Rods, Rubble, and Sand. Another author Raphel et.al [7] inspected the eleven Coral species including Platygyra, Stylophora, Lobophyllia, Acropora, Favia, Echinopora, Cyphastrea, Goniastrea, Pavona, Porites, and Mottipora in the Gulf of Eilat at four sites through natural sampling via photographing the Coral Reef during daylight, and then estimated the cover percentages at the four sites by line transect, finally using supervised deep learning methods namely ResNet-50 to classify Coral species.

In this research, we proposed using Transfer Learning (TL) ResNet-50 to classify to identify the presence of Coral Reefs species such as Acropora Clathrata, Acropora Florida, Cyphastrea Microphthalma, Diploastrea Heliopora, Pachyseris Speciosa through a smartphone or mobile application in a particular area or region. In the development of our mobile application, we used the Google Cloud Platform (GCP) that is used to deploy our Rest API for transferring data between the Front-End and the Back-End of the application so users can send and request data and display information that is needed, then the MongoDB database for storing new data of the Coral Reef. Using a smartphone has the advantage of being able to use it everywhere and anytime when needed. In addition, involving many people or society as users in gathering data would make data more varied. To make it a reality, we perform Scrum as our methodology to oblige a determined requirement and bring out a product in an instant.

II. RESEARCH METHODOLOGY

In this research, we have 2 main focuses. First, the deployment of Coral Reefs for tracking and classification in the mobile application using the Scrum framework, and lastly applying transfer learning ResNet-50 to support classification features in an application.

In Software development, we have chosen the Scrum framework as our methodology research. Scrum is one of a variety of Agile Development that is widely used today that is believed to be able to adapt to changes in requirements and produce products in a short time. It refers to the scrum team having the capability of self-organizing and cross-functional to achieve a goal. The development scrum such as Figure 1 begins with the general idea of what needs (requirement) to be built and elaborates a list of characteristics ordered by priority as known as the product backlog. In addition, sprint planning to define what can be delivered in the sprint based on the product backlog and how this work will be achieved (a division of work, software requirement, etc.). Furthermore, a sprint backlog is a list item of tasks (Subset of Product Backlog) that is identified in sprint planning before that has

to be completed by the scrum team over Sprint. In conclusion, the product that has been built will review according to the suitability of the requirements that have been determined.

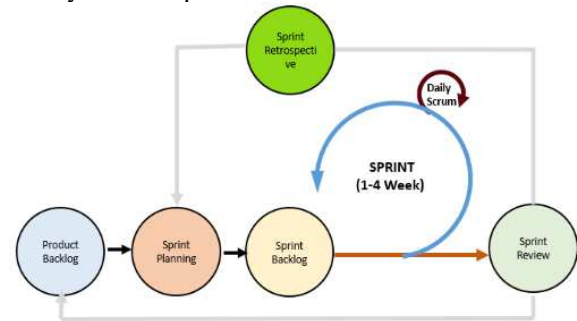


Figure 1. Workflow of Scrum for developing mobile applications.

Applying transfer learning ResNet-50 in an application has a workflow that must follow after being appointed by teamwork in the sprint planning step. An illustration workflow of transfer learning is as follows:

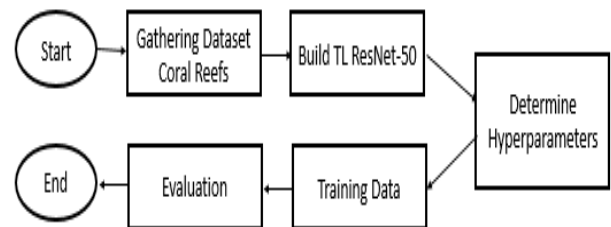


Figure 2. Workflow of building TL ResNet-50 for classification of Coral Reefs.

Firstly, we prepare datasets of Coral Reefs with species such as Acropora Clathrata, Acropora Florida, Cyphastrea Microphthalma, Diploastrea Heliopora, and Pachyseris Speciosa. In addition, we build a model of the transfer learning ResNet-50 and set up the hyperparameter property of the model. Furthermore, we train data by using the model of TF ResNet-50 that are built before and lastly evaluation the model. See Figure 2 above.

A. Implementation Scrum - Organizing Product Backlog

In the product backlog, we have to a determination of features (functional requirements) of applications that would be built on the order of priorities level. The product backlog comes from a user story that was obtained from the user through interviews, observation, and so on. This tracking and classification of Coral Reefs has a workflow that could be explained as follows and can be illustration in Figure 3 below.

1) The user selects *Add* menu to increase new information about Coral Reefs along with areas where the presence of Coral Reefs. In this menu, first, the user must input information about the area's Coral Reefs found (name of area, location, and color). Then, the user has to capture an image of Coral Reefs through a camera. The image that has been taken will be identified using Transfer Learning ResNet-50 to obtain information on Coral reefs such as the name of the species, the type of classification of Coral reefs (Hard Coral or Soft Coral), and the accuracy of classification will be displayed. The last, save all information on Coral Reefs. The saved data contains the name of the species, the coordinates of both latitude and longitude, accuracy, and the image of Coral Reefs.

2) The user also can choose *Mapping Area*. The saved data location of the existence of Coral Reefs can be displayed through a Google Maps along with other areas or locations that had been recorded earlier. The Latitude and Longitude of the location are obtained from the GPS of the mobile.

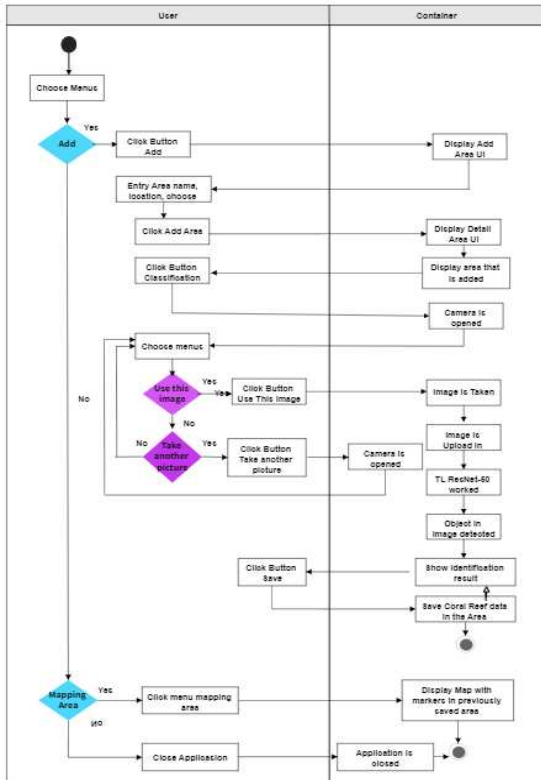


Figure 3. The flow of the System.

Based on the workflow above, the list of features that are needed for application tracking and classification on mobile can be seen in Table 1 below.

Table 1. List of Product Backlog.

No.	Backlog Item	Priority	Description
1	Object Classification	High	This backlog item is used for classifying Coral Reefs with the result that shows the name of species, type of classification of Coral Reefs (Hard Coral or Soft Coral), and accuracy of classification from a captured image from a mobile camera.
2	Tracking Location in Map	High	This backlog item is used to show the location's presence of Coral Reefs that were stored in Google Maps with marker.
3	Save data area of High Coral Reef	High	This backlog item is used to save new data on Coral Reefs in an area where Coral Reefs were founded.

Besides that, in this section, we are decided to make design an architecture system for this application, see Figure 4. The application to be built is divided into 2 parts namely Front-End and Back-End. The role of mobile as an application interface that handles interaction between user and system (Front-End). The request that was sent by a user, would be to access Rest API to continue accessing data to recognition with the data trained in model TL ResNet-50 that is deployed in Google Cloud. After that, the model would return data that

is requested through Rest API until received by a user (Back-End).

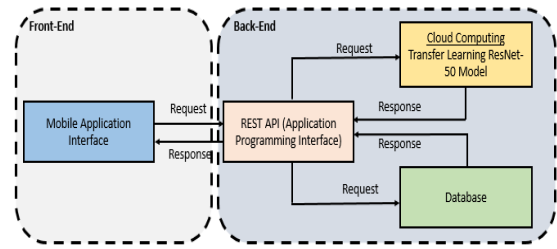


Figure 4. Design of Architecture System.

Rest API applications become a crucial part of order to exchange of data that is needed between the mobile application, cloud, and database. We design a schema database to support building Rest API application involving 2 tables that are Table Areas which is used for information about the areas where there are Coral Reefs and Table Corals which is used for information about Coral Reefs with a specified field in each table in the database as in Figure 5.

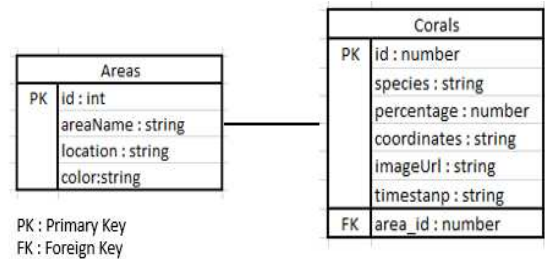


Figure 5. Design of Schema Database.

B. Implementation Scrum - Sprint Planning

Realizing what has been determined before (in Product Backlog), we make Sprint Planning for managing between features and many people that are involved. We are organized people in a team to do work based on their specialization with a destination working time plan in 2 weeks. In the Scrum team, every member of the team has to be self-organizing and cross-functional. Where every member has a specialism or competence skill and must collaborate, and together to reach a done increment (goal of Sprint). Specification role and job description in developing application mobile for tracking and classification, as seen in Table 2.

Table 2. Specification Role and Job Description.

No.	Role	Job Description
1	Project Manager (PM)	Manage and control the progress of application development.
2.	Analysis System (AS)	Communicator and interpret a need that is obtained from the owner.
3	Programmer Mobile (M)	Build a mobile application.
4	Programmer Machine Learning (ML)	Build model TL ResNet-50 with TensorFlow for identification of Coral Reefs.
5	Programmer Cloud (C)	Deploy model TL ResNet-50, configure Google Cloud Platform, and Testing integration.
6	Programmer API (A)	Create API on an application

In this section, we decided software requirements need to build in each division or role to support the progress during the application's building, see Figure 6. To manage and control the progress, we planned to use some support software such as Slack to communicate or discuss problems that have been found during development, GitHub to store, organize, and integrate code programs, and Trello to track work that has been decided in every member of a team. The Mobile Application division is built using the framework Flutter as User Interface Application, the Rest API division uses ExpressJS & Flask and MongoDB to build Rest API as connecting bridge between other applications, Cloud division uses Google Cloud Platform (Google Storage, Cloud Run & App Engine) to deploy a model of TL ResNet-50 and Rest API, configure Google Cloud Platform and testing integration, and last one, Machine Learning division applying Python, TensorFlow, Keras, and Jupyter Notebook to train data, and build model TF ResNet-50 for classification and identification of Coral Reefs.

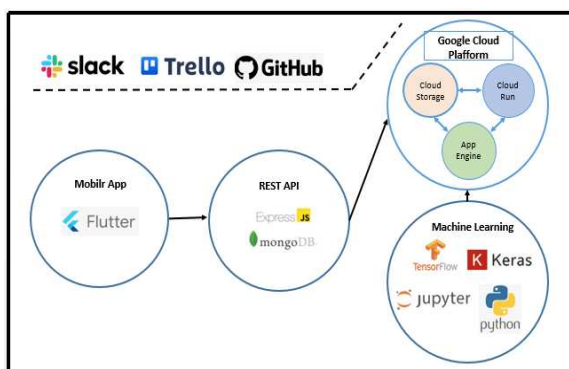


Figure 6. Software Requirement in an Application.

C. Implementation Scrum - Sprint Backlog

Sprint Backlog is the implementation of sprint planning with build features that have been determined before. In this section, every member of the team gives a task that has been decided. They implement features in the product backlog to create a module of the code program such as user interface (UI), function or procedure, algorithm, and so on. In machine learning, some tasks must be done based on a workflow to classify and identify Coral Reefs in our application; see Figure 2. For more detailed tasks for each backlog and each member in teamwork see Table 3 below.

Table 3. Specification Role and Detail Jobs each Division.

Backlog Item	Task	Member
Object Classification	Classification User Interface	M
	Preview Capture Image User Interface	M
	Classification Result User Interface	M
	Create API getCoral	A
	Create API getCorals	A
	Create API UploadImage	A
	Integrate Cloud Run	C
	Deploy Model RestNet 50 in Cloud	C
	Integrate App Engine	C
	Testing Data (Cloud)	C
	Gathering Datasets	ML
	Deploy Model RestNet 50	ML
	Determined Hyperparameters	ML
	Training Data	ML
	Evaluation	ML
	Tracking	Mapping User Interface

Backlog Item	Task	Member
Save Data Area Tracking	Integrate Google Map API	M
	Home User Interface	M
	Add Area User Interface	M
	Detail Area User Interface	M
	Create API CreateArea	A
	Create API getArea	A
	Create API getAreas	A
	Create API CreateCoralData	A
Integrate Cloud Storage	C	

During doing task Backlog in the sprint, every day all members must attend in Daily Scrum meeting or A Stand-up meeting that is held in a short time to discuss sprint progress such as the progress of a task, the problem that occurred, and the next planning task that has to do. Even though we used Trello to monitor a task (To Do, Doing, and Done), but involved Project Manager (PM) would be tracking the task of every member that has decided before and identify an issue. Moreover, daily scrum assisted us to see synchronization tasks between the member of a team, and a place to solve a problem during the sprint so can be optimized to collaborate that what the goal print can be achieved.

D. Implementation Scrum - Sprint Review

The features that have been done by every member of a team, would be demonstrated. Through this stage, we would know the appropriate functional requirements that have been requested at the beginning.

E. Implementation Scrum - Sprint Retrospective

We did a self-inspection about the task and the problems during the implementation of the build application mobile to track and classify Coral Reefs through a camera. So, can make plans for improvements to be made in the next sprint.

III. RESULT AND DISCUSSION

Our mobile application can classify and identify 5 (five) species of Coral Reefs; see Figure 6. We prepared the dataset by making our dataset of Coral Reefs with a total of 2197 images. Details in datasets contain species Acropora Clathrata has 700 images, Acropora Florida has 274 images, Cyphastrea Microphthalma has 755 images, Diploastrea Heliopora has 261 images, and Pachyseris Speciosa has 207 images. The labeling dataset is adopted as the name of species of Coral Reefs. Our dataset that has already been made is loaded in Google Collab.

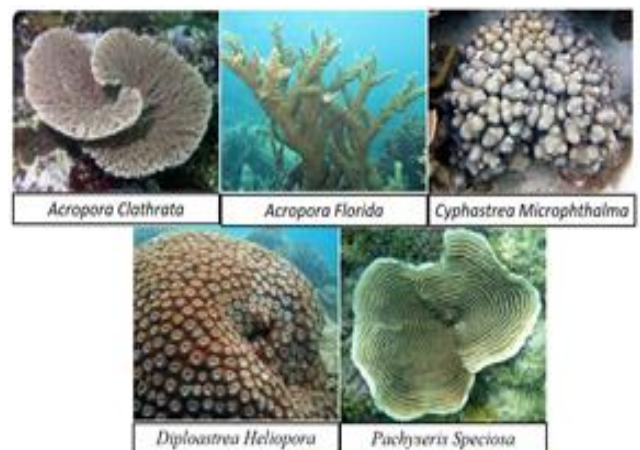


Figure 7. Species of Corel Reefs in a datasets

Build model TL ResNet-50 can use the ResNet50 function that has been provided in Python with Keras. In the TL ResNet50 model that was built, we determine hyperparameter likes using a loss function with sparse categorical cross-entropy and adam optimizer with a learning rate of 0.001, whereas, in the training data, we use 10 epochs. It means that there are 10 times that the learning process in the entire training dataset that is used. After training data is done, the ResNet-50 model would be tested using a data test to determine whether the data output is true or false so it was obtained the percentage of accuracy. The ResNet-50 model that has been built can use in Android. It can be done if we convert it into TensorFlow Lite using the function TFLiteConverter. The file converted would be deployed in Cloud so the computing process in the machine learning model would be light compared to embedding machine learning in Android considering involving the large of data that is used.

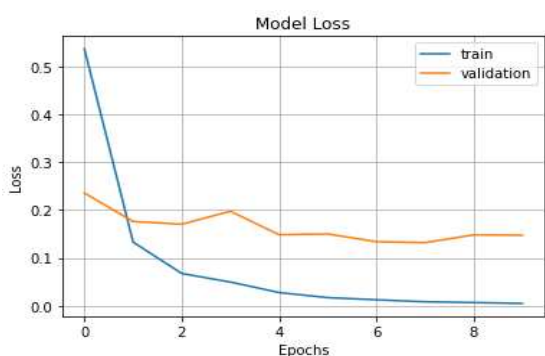


Figure 8. Loss value model ResNet-50 in each epoch

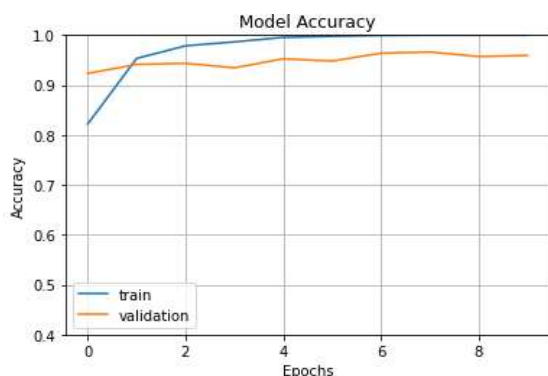


Figure 9. Accuracy level model ResNet-50 in each epoch.

The model ResNet-50 in this application uses 10 epochs to achieve the ideal model. The loss value of the model is shown in a graph that it tends to decrease along with the increase of each epoch, whereas accuracy is shown an improvement in each epoch, seen in Figure 8 and Figure 9. The accuracy percentage of approximately average at 96 %, and the loss value model is 0.2 It shows that our TL ResNet-50 model in the application mobile is good for the classification of Coral Reefs.

The development application mobile to track and classify Coral Reef using Scrum could manage the process of product development more productively with build-up collaboration, communication, and openness between teamwork to deliver produce a product that is desired. Product implementation scrum methodology in a mobile application to track and classify Coral Reef can see in Figure 10. The interface to add area has a function to input new data area that would be

shown in the detail area interface that area that is added before. To add Coral Reef data in that area, the application will classify an object in an image, then identify and show information about it. Coral Reefs that have been identified in that area will display in Google Maps with the marker.

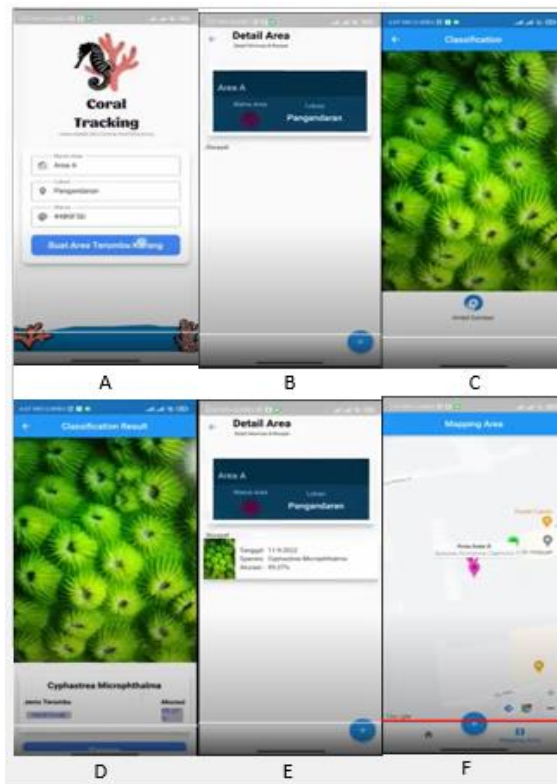


Figure 10. User Interface Application Mobile.

IV. CONCLUSION

The development application mobile using Flutter to track and classify Coral Reef involves services of the Google Cloud Platform, Rest API, and TL ResNet-50 with the Scrum methodology in software development has been a result of the product in a short time with a managed process of development. Used TL ResNet-50 model has good accuracy with results in 0.9594 or 96% can identify Coral Reefs well. Certainly, it will support features of the application in the classification of the identification of Coral Reefs. In the future, it is hoped that the application can be developed according to the business process or requirement functional of the system and implementation architecture system that can do in underwater.

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